

50 years

of study and 200 papers



Research findings update

This briefing summarises the main findings from over 60 papers on the Midspan studies published since 2005 and provides an overview of studies of mortality since 1978. It updates the newsletter produced at the time of the 30-year Midspan celebratory symposium in 2005.

Introduction

For 50 years, the Midspan studies have provided valuable information about health and disease in Renfrew, Paisley and the west and central belt of Scotland. The studies recruited almost 30,000 participants and then followed their health records over many years to see who gets what, who doesn't and why. A key feature has been continued follow-up by linkage to NHS death, cancer and hospital discharge registers.

The results don't just inform us about health in Scotland. Because of the large and representative nature of the cohorts, the virtually complete follow-up and the characteristics of the area they were drawn from – a rapidly de-industrialised conurbation with high levels of social deprivation, cancer and heart disease – they are relevant to similar populations in many parts of the world.

Another major strength of the Midspan studies is that over 50% of the participants in the Renfrew and Paisley Study were women, at a time when other UK epidemiological studies included only men. An unexpected bonus of the high response rate in the Renfrew and Paisley Study (around 80%) was the inclusion of many married couples, enabling a subsequent family study to be started. Goodwill, study loyalty and the support of local family doctors made this a reality. Having occupational as well as general population cohorts in a similar area is another strength. The Collaborative cohort was well suited for life course studies as information was collected on socioeconomic factors in childhood and early adulthood.



The studies

The **Main Study (1964–68)** involved 13 factories in the central belt of Scotland and 4,000 people aged 15 to 70, of whom more than 500 were women. The Midspan team then visited the Hebridean island of **Tiree (1967)** to record the health details of all 532 residents over the age of 15, plus 230 of their relatives who had settled on the mainland.

The **Collaborative Study (1970–73)** was an occupational cohort study of 6,022 men and 1,006 women recruited from 27 workplaces throughout the central belt of Scotland. About 50% of participants were restudied in 1977.

The **Renfrew and Paisley Study (1972–76)** was a general population study of 8,353 women and 7,049 men, comprising 80% of residents aged 45–64 living in Renfrew and Paisley at the time. About 50% of participants were restudied in 1977–79. From 1999, 200 surviving participants also took part in the PREVAIL study of healthy ageing and another 200 took part in a study on quality of life and cognitive functioning.

The **Family Study (1996)** recruited 1,298 daughters and 1,040 sons, aged 30–59, of parents who both took part in the original Renfrew and Paisley Study. In 2002, 556 surviving parents provided blood samples for DNA analysis in the TWOGEN study. In 2003, daughters provided information on the birth weights of 1,800 infants – grandchildren of the original cohort.

All participants completed a questionnaire about their background and their health. Their weight, height and blood pressure were measured, tests were carried out to assess heart and lung function and a blood sample was taken. Since recruitment, the study coordinators have regularly received secure and confidential information from the NHS about the date and cause of death of any participant and admissions to hospital and confirmed cases of cancer of participants in all cohorts except the Main and Tiree Studies.

Lifespan and causes of death

By the end of 2012, 91% of men and 84% of women in the Renfrew and Paisley Study had died; 69% of men survived to their 70th birthday and 36% to their 80th; 82% of women survived to their 70th birthday and 55% to their 80th.

The commonest causes of death were:

	Men	Women
Coronary heart disease	31%	23%
Cancer	28%	25%
Stroke	11%	16%
Respiratory disease	11%	11%
Other	19%	25%

Scientific papers

By August 2014, the Midspan studies had resulted in over 200 scientific papers published in 79 scientific journals, including 19 in the *British Medical Journal* and nine in the *Lancet*. After an initial flurry of 32 papers in the 1960s and 1970s, only 13 were published in the next decade, followed by 41 in the 1990s, 91 from 2000 to 2009 and 24 since then. In the past 10 years, 61 papers have been published.

Base and funding

The Midspan Studies are based in the Institute of Health and Wellbeing at the University of Glasgow (Public Health and General Practice and Primary Care). They have been funded by a large variety of organisations. For example, the original Renfrew and Paisley study was funded by the Renfrewshire King Edward Memorial Fund. Since 2005, core funding has been provided by NHS Health Scotland and NHS Greater Glasgow & Clyde Health Board Endowment Funds.

More information is available on the website (www.gla.ac.uk/midspan) or by contacting the Midspan administrator at midspanadmin@glasgow.ac.uk or 0141 330 4072.

Key findings from the last 10 years

- Higher exposure to black smoke air pollution was associated with higher short- and long-term mortality rates (page 4).
- The risk of having a hospital admission for stroke, respiratory disease and liver disease was increased for men drinking >14 units of alcohol per week. Mental health admissions and bed-days were higher for drinkers of >21 units of alcohol per week (page 5).
- While men who stopped smoking had lower long-term mortality, there was little evidence of lower mortality in men who reduced the number of cigarettes they smoked (page 6).
- Both overweight and obesity were associated with important increases in all-cause and cause-specific mortality, in particular due to cardiovascular disease (page 6).
- Compared with underweight or normal weight men, obese men had more than three times the mortality rate due to liver disease (page 7). Obese men drinking more than 14 units of alcohol a week had almost 19 times the mortality rate due to liver disease (page 8).
- Compared with people with a normal weight, the overweight were 2.7 times more likely and the obese 7.3 times more likely to develop diabetes (page 8).
- IQ at 11 was strongly related to adult social class and upward and downward social mobility. It was inversely related to mortality occurring before age 65, but not related to mortality occurring after age 65 (page 11).
- The higher all-cause, respiratory and lung cancer mortality in the Midspan men compared to Whitehall male civil servants was largely explained by social class differences and the higher prevalence of known risk factors. The excess mortality from stroke, alcohol-related causes, accidents and suicide remained unexplained (page 13).
- Both male and female smokers in all social classes had poorer survival than never-smokers in even the lowest social classes. Smoking cancelled out women's otherwise large survival advantage over men (page 15).
- Among women who had never smoked, non-obese women had the lowest mortality rates, with little difference between social classes (page 15).

Health effects of air pollution

Association between long-term exposure to air pollution and specific causes of mortality in Scotland. Yap C, Beverland IJ, Heal MR, Cohen GR, Robertson C, Henderson DEJ, Ferguson NS, Hart CL, Morris G, Agius RM. *Occup Environ Med.* 2012;69:916–24. doi: 10.1136/oemed-2011-100600.

Comparison of models for estimation of long-term exposure to air pollution in cohort studies. Beverland IJ, Robertson C, Yap C, Heal MR, Cohen GR, Henderson DEJ, Hart CL, Agius RM. *Atmospheric Environment.* 2012;62:530–9. doi: 10.1016/j.atmosenv.2012.08.001.

A comparison of short-term and long-term air pollution exposure associations with mortality in two cohorts in Scotland. Beverland IJ, Cohen GR, Heal MR, Carder M, Yap C, Robertson C, Hart CL, Agius RM. *Environmental Health Perspectives.* 2012;120:1280–5. doi:10.1289/ehp.1104509.

A team of environmental scientists and public health specialists examined the health effects of outdoor air pollution on the members of the Renfrew and Paisley and Collaborative cohorts using measurements of black smoke concentrations made at multiple sites in the 1970s. The main challenge in the research was to estimate exposure to air pollution at the homes of the

participants, as there were only five air pollution monitoring sites operating in Renfrew and Paisley in the 1970s when participants were recruited into the study. The relationship between measured air pollution and nearby household density (relating to emissions from nearby chimney pots) and nearby busy roads was thus examined at around 180 pollution monitoring sites across Scotland to allow pollution concentrations to be estimated at locations without monitoring sites. A novel aspect of the research was to compare the health effects of air pollution exposure over different timescales (days, months and decades).

After taking into account other known individual and social factors that also influence mortality, significant associations were observed between higher estimated residential air pollution exposure and higher short- and long-term mortality rates. This was the first published cohort study of air pollution exposure and health outcomes in the UK. The observed associations between air pollution and health are consistent with a small number of similar cohort studies in other countries and provide important evidence for the setting of air quality standards to protect public health in the UK.

Tobacco and alcohol

Carboxyhaemoglobin concentration, smoking habit, and mortality in 25 years in the Renfrew/Paisley prospective cohort study. Hart CL, Davey Smith G, Hole DJ, Hawthorne VM. *Heart*. 2006;92:321–4.

Blood carboxyhaemoglobin concentrations are an indicator of exposure to tobacco smoke and were measured in 7,564 participants in the Renfrew and Paisley Study. Concentrations were closely related to the self-reported number of cigarettes smoked and were higher in smokers who reported inhaling than in those who reported not inhaling. Over 25 years of follow-up, they were positively related to mortality from all causes, coronary heart disease, stroke, chronic obstructive pulmonary disease and lung cancer. These relationships remained even after additionally adjusting for cigarette smoking. Carboxyhaemoglobin was a better indicator of the risk associated with smoking than self-reported tobacco use. Analysing mortality by self-reported smoking may thus underestimate the association between smoking and mortality.

Alcohol consumption and mortality and hospital admissions in men from the Midspan Collaborative cohort study. Hart CL, Davey Smith G. *Addiction*. 2008;103:1979–86.

Alcohol consumption and use of acute and mental health hospital services in the West of Scotland Collaborative prospective cohort study. Hart CL, Davey Smith G. *J Epidemiol Community Health*. 2009;63:703–7. doi:10.1136/jech.2008.079764.

In the Collaborative Study, the risk of hospital admission for stroke, respiratory disease and liver disease was increased for men drinking >14 units of alcohol per week. Numbers of general hospital admissions were higher for drinkers of >21 units. Bed-days were higher from >7 units and increased with the amount drunk, with the heaviest drinkers (>34 units) having a 58% higher rate. Non-drinkers had the highest admissions for coronary heart disease, but admissions and bed-days for other causes generally increased with consumption. Mental health admissions and bed-days were higher for drinkers of >21 units.

Alcohol consumption behaviours and social mobility in men and women of the Midspan Family study. Hart CL, Davey Smith G, Upton MN, Watt GCM. *Alcohol & Alcoholism*. 2009;44:332–6.

Using detailed alcohol measures from the Family Study, we studied how social class and mobility related to exceeding recommended alcohol limits for daily drinking (4 units for men, 3 units for women), weekly drinking (21 and 14 units), binge drinking (8 and 6 units) and drinking on no more than 5 days per week. Among both men and women, the downwardly mobile were the most likely to exceed the weekly and daily limits but the differences were not statistically significant. Stable non-manual women were the most likely to consume alcohol on >5 days a week but very few were binge drinkers. Stable non-manual and upwardly mobile men and women were more likely to drink wine, and downwardly mobile men more likely to drink beer.

The combined effect of smoking tobacco and drinking alcohol on cause-specific mortality: a 30 year cohort study. Hart CL, Davey Smith G, Gruer L, Watt GCM. *BMC Public Health*. 2010;10:789. doi:10.1186/1471-2458-10-789.

In the Collaborative Study, the mortality rate of men who both smoked and drank >14 units/week was 2.7 times that of never smokers who did not drink. Relative rates for coronary heart disease mortality were high for current smokers, with a possible protective effect of some alcohol consumption in never smokers. Stroke mortality increased with both smoking and alcohol consumption. Smoking affected respiratory mortality with little effect of alcohol. Premature mortality was particularly high in smokers who drank >14 units, with a quarter of these men not surviving to age 65. 30% of men with manual occupations both smoked and drank >14 units/week compared with only 13% with non-manual ones.

Does smoking reduction in midlife reduce mortality risk? Results of 2 long-term prospective cohort studies of men and women in Scotland. Hart C, Gruer L, Bauld L. *American Journal of Epidemiology*. 2013;178(5):770–9. doi: 10.1093/aje/kwt038.

A long-term study of working men in Israel showed that smokers who reduced their cigarette consumption had lower mortality rates than those who maintained the same level. Data from the Collaborative and Renfrew and Paisley cohorts were analysed to see if these results could be replicated. There was no evidence of lower overall mortality in reducers compared with maintainers in either of the cohorts, but clear evidence of lower mortality in quitters. In the Collaborative Study only, heavy smokers of >20 cigarettes/day who reduced the amount smoked did have lower mortality than maintainers, but this was not seen in lighter smokers in this cohort or in either heavy or lighter smokers from the Renfrew and Paisley Study.

Obesity and diabetes

Reverse causality and confounding and the associations of overweight and obesity with mortality. Lawlor DA, Hart CL, Hole DJ, Davey Smith G. *Obesity* 2006;14:2294–304.

Long-term cardiovascular consequences of obesity: 20-year follow-up of more than 15,000 middle-aged men and women (the Renfrew and Paisley Study). Murphy NF, MacIntyre K, Stewart S, Hart CL, Hole D, McMurray JJV. *Eur Heart J*. 2006;27:96–106.

Body mass index in middle life and future risk of hospital admission for psychoses or depression: findings from the Renfrew/Paisley study. Lawlor DA, Hart CL, Hole DJ, Gunnell D, Davey Smith G. *Psychological Medicine*. 2007;37:1151–61.

Obesity and use of acute hospital services in participants of the Renfrew/Paisley study. Hart CL, Hole DJ, Lawlor DA, Davey Smith G. *J Public Health*. 2007;29:1:53–6.

There has been an ongoing debate about the effect of overweight and obesity on mortality, with some suggestion that any causal association has been exaggerated. Others have argued that reverse causality (other illnesses resulting in both weight loss and increased mortality) and smoking (limiting weight gain and increasing mortality) may have resulted in some studies underestimating the true effect of overweight and obesity on mortality.

Analysis of data from the Collaborative and Renfrew and Paisley Studies showed that, with appropriate adjustment for reverse causality and smoking, both overweight and obesity were associated with important increases in all-cause and cause specific mortality, in particular with cardiovascular disease mortality. Obesity was also associated with a much broader long-term cardiovascular risk due to heart failure, venous thromboembolism, atrial fibrillation (in women) and, probably, stroke.

Body mass index (BMI) was also related to hospital use. Admission rates for underweight and normal weight men were lower than expected, and those of overweight and obese men were higher than expected. Obese men had higher bed-day rates. Normal weight women had the lowest admission and bed-day rates, with underweight and obese women having similar higher rates of both. Conversely, hospital admissions for psychoses or depression were inversely related to BMI.

Contribution of midparental BMI and other determinants of obesity in adult offspring.

Abu-Rmeileh NME, Hart CL, McConnachie A, Upton MN, Lean MEJ, Watt GCM. *Obesity*. 2008;16:1388–93.

Intergenerational change and familial aggregation of body mass index.

Johnson PCD, Logue J, McConnachie A, Abu-Rmeileh NME, Hart C, Upton MN, Lean M, Sattar N, Watt G. *Eur J Epidemiol*. 2012;27:53–61. doi 10.1007/s10654-011-9639-5.

It is increasingly recognised that overweight and obesity runs in families. What is not known is whether this is down to genetics or learned eating behaviours from an early age. The Family Study has added to our understanding of the association of the weight of adult offspring with that of their parents. It showed that daughters' BMIs were more strongly associated with their mother's BMI than their father's. However, sons' BMIs were equally associated with both their mother's and father's BMI. Intergenerational increase in BMI was disproportionately greater in the offspring of heavier parents. Low physical activity, non-smoking status, higher cholesterol and manual social class were associated with higher BMI. Mid-parental BMI, defined as the mean of the mother's and father's BMI, had a strong independent effect on offspring BMI and could be a useful tool to predict offspring BMI.

Obesity, overweight and liver disease in the Midspan prospective cohort studies.

Hart CL, Batty GD, Morrison DS, Mitchell RJ, Davey Smith G. *International Journal of Obesity*. 2010; 34:1051–9. doi: 10.1038/ijo.2010.20.

Using data from the Main, Collaborative and Renfrew and Paisley studies, higher BMI at screening was strongly related to higher mortality rates due to liver disease in men but not women. Obese men had more than three times the rate of liver disease mortality of underweight or normal weight men. When liver disease was ascertained from all sources (hospital discharge data, cancer registration data or any diagnosis on the death certificate), similar strong associations between BMI and liver disease were seen for men, with evidence of a weaker association in women.

Effect of body mass index and alcohol consumption on liver disease: analysis of data from two prospective cohort studies. Hart CL, Morrison DS, Batty GD, Mitchell RJ, Davey Smith G. *BMJ*. 2010;340:c1240. doi:10.1136/bmj.c1240.

Using data from the Main and Collaborative cohorts, a raised BMI and higher alcohol consumption were both related to higher mortality due to liver disease and their combined effect was greater than the sum of their separate effects. The mortality rate from liver disease was almost 19 times higher among obese men drinking >14 units a week than among underweight or normal weight non-drinkers. This suggests that combining strategies to reduce both alcohol consumption and obesity in populations would be helpful.

How many cases of Type 2 diabetes mellitus are due to being overweight in middle age? Evidence from the Midspan prospective cohort studies using mention of diabetes mellitus on hospital discharge or death records. Hart CL, Hole DJ, Lawlor DA, Davey Smith G. *Diabetic Medicine*. 2007;24:73–80.

We selected men and women from the Renfrew and Paisley Study and men from the Collaborative Study who did not have diabetes at recruitment. Their BMIs were related to the subsequent development of diabetes using diagnoses in hospital discharge records and death records during the period from recruitment in 1970–76 to 2004. Around 5% of the cohort developed Type 2 diabetes during the follow-up period. Among men in the Renfrew and Paisley Study, after adjusting for age, the overweight group was 2.7 times more likely and the obese group 7.3 times more likely to have developed diabetes than the normal weight group. Similarly high odds ratios were found among women in the Renfrew and Paisley Study and men in the Collaborative Study. Assuming a causal relationship, around 60% of diabetes cases could have been prevented if everyone had been of normal weight. With recent increases in the prevalence of overweight, the burden of disease related to diabetes is likely to increase markedly.

Coronary heart disease

A population study of the long-term consequences of Rose angina: 20-year follow-up of the Renfrew-Paisley study. Murphy NF, Stewart S, Hart CL, MacIntyre K, Hole D, McMurray JJV. *Heart*. 2006;92:1739–46.

Participants in the Renfrew and Paisley Study were assessed for angina at recruitment using the Rose Angina Classification: 9.5% of men and 9.6% of women had angina. After 20 years of follow-up, all-cause mortality for those with angina was 68% in men and 43% in women compared with 45% and 30%, respectively, for those without angina. Men and women with angina were both more likely than those without angina to experience cardiovascular death or hospitalisation, myocardial infarction and heart failure. Among those with angina, women were about half as likely as men to experience a cardiac event or myocardial infarction, but rates for women and men were similar for stroke, atrial fibrillation and heart failure.

Parental height in relation to offspring coronary heart disease: examining transgenerational influences on health using the west of Scotland Midspan Family Study Gray L, Davey Smith G, McConnachie A, Watt GCM, Hart CL, Upton MN, Macfarlane PW, Batty GD. *Int J Epidemiol*. 2012;41:1776–85. doi:10.1093/ije/dys149.

The Family Study was used to investigate the transgenerational influence of parental height on their offspring's risk of cardiovascular disease. Taller paternal and/or maternal height was associated with socioeconomic advantage, heavier birthweight and increased high-density lipoprotein cholesterol in offspring. The offspring of taller mothers and, to a lesser extent, taller fathers had a lower incidence of heart disease. The decrease in risk was 15% for every 5.6 cm increase in the height of the mother. The association remained after accounting for differences in age, sex, the height of the other parent and factors in the offspring linked with heart disease risk, including their own height. This may reflect an influence of early maternal growth on the intrauterine environment provided for her offspring.

Psychological distress

Psychological distress, physical illness, and risk of coronary heart disease. Rasul F, Stansfeld SA, Hart CL, Davey Smith G. *J Epidemiol Community Health*. 2005;59:140–5.

Psychological distress and chronic obstructive pulmonary disease in the Renfrew and Paisley (MIDSPAN) study. Pembroke TPI, Rasul F, Hart CL, Davey Smith G, Stansfeld SA. *J Epidemiol Community Health*. 2006;60:789–92.

Psychological distress in physically ill men greatly increased the risk of coronary heart disease. There was no evidence to show any similar association in women. Psychological distress was associated with chronic obstructive pulmonary disease (COPD) and predicted COPD in women who were rescreened a few years later.

Cancer

Coffee consumption and prostate cancer risk: further evidence for inverse relationship. Shafique K, McLoone P, Qureshi K, Leung H, Hart C, Morrison DS. *Nutrition Journal*. 2012;11:42. doi:10.1186/1475-2891-11-42.

Tea consumption and the risk of overall and grade specific prostate cancer: a large prospective cohort study of Scottish men. Shafique K, McLoone P, Qureshi K, Leung H, Hart C, Morrison DS. *Nutrition and Cancer*. 2012 (online). doi:10.1080/01635581.2012.690063.

Cholesterol and the risk of grade-specific prostate cancer incidence: evidence from two large prospective cohort studies with up to 37 years' follow up. Shafique K, McLoone P, Qureshi K, Leung H, Hart C, Morrison DS. *BMC Cancer*. 2012;12:25.

Lung and breast cancers were the commonest malignancies when the Midspan studies began. Scotland had some of the highest rates of both cancers in the world and a diagnosis was often considered a death sentence. In 2014, lung and breast cancers remain the commonest malignancies overall in Scotland, but the rest of the landscape has changed a great deal. In men, prostate cancer has overtaken lung cancer to become the commonest malignancy. The risk of being diagnosed with prostate cancer is expected to increase by about 30% in the next decade while lung cancer rates will continue to decline.

The Midspan studies have allowed us to follow-up men over several decades to explore risk factors for developing prostate cancer. The results, however, raise further questions. Have we learned more about what leads to a long and otherwise healthy life or about what might actually cause prostate cancer?

Vitamin D

Circulating 25OHD, dietary vitamin D, PTH, and calcium associations with incident cardiovascular disease and mortality: the Midspan Family Study. Welsh P, Doolin O, McConnachie A, Boulton E, McNeil G, Macdonald H, Hardcastle A, Hart C, Upton M, Watt G, Sattar N. *J Clin Endocrinol Metab.* 2012;97(12):4578–87. doi:10.1210/jc.2012-2272.

Vitamin D is widely known as the ‘sunshine vitamin’, and levels of the vitamin are known to be low in Scots. It has frequently been reported in the media that low vitamin D is bad for your health. Using stored blood samples from the Family Study, we found that almost a third of people could be classified as ‘deficient’ in vitamin D. Those who were deficient in vitamin D were not at increased risk of heart attacks over the next 14 years, although they did have approximately twice the risk of dying of any cause. This does not necessarily mean that low levels of vitamin D cause death. We found evidence that low vitamin D is a consequence (rather than a cause) of poor health. We do not currently recommend the use of sunbeds, sunbathing or supplements to raise your levels of vitamin D; a healthy lifestyle including a balanced diet and physical activity best optimises health.

Genetics

Genetic association study of QT interval highlights role for calcium signalling pathways in myocardial repolarization. Arking D et al. *Nature Genetics.* 2014;46:826–36.

Association between genetic variants on chromosome 15q25 locus and objective measures of tobacco exposure. Munafo MR et al. *Journal of the National Cancer Institute.* 2012;104:1–9. doi: 10.1093/jnci/djs191.

Genetic variation at CHRNA5-CHRNA3-CHRNA4 interacts with smoking status to influence body mass index. Freathy RM et al. 2011;40:1617–28. doi:10.1093/ije/dyr077.

Genetic variation at the SLC23A1 locus is associated with circulating concentrations of L-ascorbic acid (vitamin C): evidence from 5 independent studies with >15,000 participants. Timpson NJ et al. *Am J Clin Nutr.* 2010;92:375–82.

Since the first draft of the human genome sequence was released in 2001 there has been a revolution in genomic technology, with discoveries of variations in the genome that may be important in health and disease. The Family Study has contributed significantly to large genomic studies that have advanced our understanding of health and disease. In a study of over 100,000 people that included the Family Study, we identified a previously unknown role for calcium signalling in the resetting of the heart after every heartbeat. This has major implications in studies of sudden death. The Family Study also contributed to the discovery of a genetic variant that relates to heaviness of smoking and the interaction between this genetic variant and smoking status on BMI. Finally, the Family Study contributed to the first evidence that variation in a gene affects circulating vitamin C levels.

Childhood IQ

Intergenerational social mobility and mid-life status attainment: Influences of childhood intelligence, childhood social factors, and education. Deary IJ, Taylor MT, Hart CL, Wilson V, Davey Smith G, Blane D, Starr JM. *Intelligence* 2005;33:455–72.

Childhood IQ and all-cause mortality before and after age 65: Prospective observational study linking the Scottish Mental Survey 1932 and the Midspan studies. Hart CL, Taylor MD, Davey Smith G, Whalley LJ, Starr JM, Hole DJ, Wilson V, Deary IJ. *Brit J Health Psychol.* 2005;10:153–65.

Childhood IQ and social factors on smoking behaviour, lung function and smoking-related outcomes in adulthood: linking the Scottish Mental Survey 1932 and the Midspan studies. Taylor MD, Hart CL, Davey Smith G, Starr JM, Hole DJ, Whalley LJ, Wilson V, Deary IJ. *Br J Health Psychol.* 2005;10:399–410.

Childhood IQ and marriage by mid-life: the Scottish Mental Survey 1932 and the Midspan studies. Taylor MD, Hart CL, Davey Smith G, Whalley LJ, Hole DJ, Wilson V, Deary IJ. *Personality and Individual Differences.* 2005;38:1621–30.

Childhood IQ of parents related to characteristics of their offspring: Linking the Scottish Mental Survey 1932 to the Midspan Family Study. Hart CL, Deary IJ, Davey Smith G, Upton MN, Whalley LJ, Starr JM, Hole DJ, Wilson V, Watt GCM. *J Biosoc Sci.* 2005;37:623–39.

Records of 932 Collaborative and Renfrew and Paisley Study participants born in 1921 were linked to the 1932 Scottish Mental Survey. This was a mental ability test, taken by virtually all 11-year-old pupils in schools throughout Scotland. IQ at 11 years was found to be strongly related to adult social position and upward and downward social mobility. It was inversely related to mortality occurring before age 65, but not related to mortality occurring after age 65. Childhood IQ had an indirect effect on smoking consumption via deprivation category. Higher childhood IQ was associated with stopping smoking in adulthood. Men with higher IQ were more likely ever to marry, whereas women with higher IQ were less likely ever to marry.

Participants' IQ in childhood was also related to characteristics of their offspring. Higher parental IQ was associated with taller offspring, better education, offspring social class and offspring deprivation category. Parental IQ was inversely related to the number of cigarettes smoked by offspring.

Ageing

Successful ageing in an area of deprivation: Part 1 – A qualitative exploration of the role of life experiences in good health in old age. Gilhooly M, Hanlon P, Mowat H, Cullen B, Macdonald S, Whyte B. *Public Health.* 2007;121:807–813.

Successful ageing in an area of deprivation: Part 2 – A quantitative exploration of the role of personality and beliefs in good health in old age. Gilhooly M, Hanlon P, Cullen B, Macdonald S, Whyte B. *Public Health.* 2007; 121:814–821.

For these two papers, the authors selected a sample of 100 matched pairs (53 male and 47 female, ages 71–90) from the Renfrew and Paisley cohort. They were stratified by health status, age, gender and social status. A subgroup of 22 pairs initially underwent a qualitative interview on their current circumstances. All 100 pairs completed an extensive questionnaire including a number of validated tests of personality and cognitive functioning.

No significant differences in current circumstances were found between the more and less healthy groups. Compared to the unhealthy group, the healthy participants were less neurotic, more likely to feel in control of their circumstances, to report a greater sense of coherence and score lower on a measure of spirituality.

Real-world problem solving and quality of life in older people. Gilhooly ML, Gilhooly K J, Phillips LH, Harvey D, Brady A, Hanlon P. *Br J Health Psychol.* 2007;12:587–600.

Cognitive ageing: activity patterns and maintenance intentions. Gilhooly KJ, Gilhooly ML, Phillips LH, Harvey D, Murray A, Hanlon P. *International Journal of Aging and Human Development.* 2007;65(3):259–280.

In these two papers, a separate sample of 73 men and 72 women aged 70–91 from the Renfrew and Paisley cohort underwent a series of tests of abstract cognitive functioning, real world problem-solving and quality of life measures.

Self-rated health, objective health status, self-rated cognitive function and real-world problem-solving all make significant independent contributions to predicting quality of life. The degree of involvement in mentally demanding activities was positively related to a measure of fluid intelligence after other factors were accounted for. There was less cognitive decline among those who intentionally engaged in activities to maintain cognitive function. Social and physical activities were not related to the cognitive measures.

Bereavement

Effect of conjugal bereavement on mortality of the bereaved spouse in participants of the Renfrew/Paisley study. Hart CL, Hole DJ, Lawlor DA, Davey Smith G, Lever TF. *J Epidemiol Community Health.* 2007;61:455–60.

There were over 4000 married couples who took part in the Renfrew and Paisley Study. In the follow up period, 59.5% of women and 27.1% of men were bereaved. Bereaved participants were at increased risk of dying from all causes, cardiovascular disease, coronary heart disease, stroke, all cancer, lung cancer, smoking-related cancer and accidents or violence compared with non-bereaved participants. After adjustment for confounding variables, the risks remained higher for all these causes except for lung cancer mortality. There was no strong evidence that the increased risks changed with time after bereavement.

Socioeconomic factors

Effect of socioeconomic deprivation on the population risk of incident heart failure hospitalisation: An analysis of the Renfrew/Paisley study. Stewart S, Murphy NM, McMurray JJV, Jhund P, Hart CL, Hole D. *European Journal of Heart Failure.* 2006;8:856–63.

Plasma C reactive protein concentration indicates a direct relation between systemic inflammation and social deprivation. O'Reilly DSTJ, Upton MN, Caslake MJ, Robertson M, Norrie J, McConnachie A, Watt GCM, Packard CJ. *Heart.* 2006;92:533–5.

In Renfrew and Paisley Study participants, greater social deprivation was associated with having a hospital admission for heart failure, irrespective of baseline cardiorespiratory status and cardiovascular risk factors. Higher Plasma C reactive protein was observed in Family Study participants living in more deprived areas.

Risk factors in the Midspan family study by social class in childhood and adulthood. Hart C, McConnachie A, Upton M, Watt G. *Int J Epidemiol.* 2008;37:604–14.

Risk factors in adult offspring in the Family Study had improved compared with parents, except for BMI and obesity which had worsened. Risk factors were less favourable in manual than non-manual offspring, and were more closely related to own rather than father's social class. There was a large amount of upward social mobility involving 35% of sons and 50% of daughters. Risk factors for the upwardly mobile were more favourable than the class they left behind but less favourable than the class they joined.

How can socioeconomic inequalities in hospital admissions be explained? A cohort study. McCartney G, Hart C, Watt G. *BMJ Open*. 2013;3:e002433. doi: 10.1136/bmjopen-2012-002433.

Social patterning of hospital admissions and bed-days in up to 37 years of follow-up was investigated using data from the Renfrew and Paisley Study. Overall admissions to hospital were only marginally socially patterned, and less than would be expected on the basis of the gradient in baseline risk. Social patterning was seen for bed-days, and could be explained by baseline risk factors. There was marked social patterning in admissions for mental health problems. Emergency admissions were higher in the lowest social classes but there was an inverse relationship for non-emergency admissions.

Comparisons with other cohorts

Why do males in Scotland die younger than those in England? Evidence from three prospective cohort studies. McCartney G, Shipley M, Hart C, Davey Smith G, Kivimäki M, Walsh D, Watt GC, Batty GD. *PLoS ONE*. 2012;7(7):e38860. doi:10.1371/journal.pone.0038860.

The Midspan studies have been very useful in helping understand health inequalities principally because of the socially diverse populations from which the data were drawn, the high response rates in the population, the high quality of the baseline data collected, the long follow-up time and the robust systems in place for ascertaining subsequent mortality and hospital admissions.

However, the design of the Midspan studies limits their ability to look at changes in exposures over time or the health outcomes of later birth cohorts. There is therefore value in comparing the Midspan studies with others with multiple waves of data collection, with those with a wider group of birth cohorts and with studies with similar data but in other locations.

We compared male mortality in the Collaborative and Renfrew and Paisley Studies with that in the Whitehall I cohort of civil servants in south-east England. Age-adjusted mortality was 25% higher in the Collaborative Study and 45% higher in the Renfrew and Paisley Study. The higher all-cause, respiratory and lung cancer male mortality in the Scottish cohorts was almost entirely explained by social class differences and the higher prevalence of known risk factors, but the excess mortality from stroke, alcohol-related causes, accidents and suicide remained unexplained.

Respiratory impairment

The significance of respiratory impairment for Public Health in Scotland. Report of a symposium held at Glasgow University on 17 February 2011. Watt, G. www.gcph.co.uk/publications/289_the_significance_of_respiratory_impairment_for_public_health_in_scotland

A symposium on Respiratory Impairment and Public Health in Scotland in 2011 reviewed the Midspan findings and confirmed the importance of respiratory impairment as a major predictor of disease-specific and all-cause mortality in men and women, including never smokers, based on Midspan and other Scottish cohorts.

The association of respiratory impairment with mortality from most causes, extending far beyond respiratory disease, provides a substantial additional explanation of poor health in Scotland in general, and the west of Scotland in particular. It is possible that these observations may add to understanding of the 'Glasgow and Scottish Effects', which have been described, mostly on the basis of ecological data, as the component of high mortality rates in Glasgow and Scotland not explained by other risk factors.

An overview of Midspan studies of mortality

About 50 papers published between 1978 and 2014, including 15 published since 2005, examined all-cause and cause-specific mortality rates in the Main and Tiree, Collaborative, and Renfrew and Paisley cohorts. Here are some of the key papers and their main findings.

Cigarette smoking and male lung cancer in an area of very high incidence – II Report of a general population cohort study in the west of Scotland. Gillis CR, Hole DJ, Hawthorne VM. *J Epidemiol Community Health*. 1988;42 (1):44–8.

This paper showed higher rates of lung cancer mortality among smokers in all three cohorts than those reported in other parts of the world but somewhat lower relative risks compared with never-smokers. This suggested that never smokers in the West of Scotland had relatively high rates of lung cancer.

Passive smoking and cardiorespiratory health in a general population in the west of Scotland. Hole DJ, Gillis CR, Chopra C, Hawthorne VM. *Br Med J*. 1989;299:423–7.

The Midspan studies were among the first to provide strong evidence of the adverse effects of second-hand tobacco smoke, including higher rates of respiratory and cardiovascular symptoms and higher mortality rates from lung cancer and cardiovascular disease.

Impaired lung function and mortality risk in men and women: findings from the Renfrew and Paisley prospective population study. Hole DJ, Watt GCM, Davey Smith G, Hart CL, Gillis CR, Hawthorne VM. *Br Med J*. 1996; 313:711–5.

In a study of the Renfrew and Paisley cohort, after adjustment for age, social class and a range of other risk factors including smoking, impaired lung function was found to be the strongest predictor of increased mortality from respiratory disease, cardiovascular disease and cerebrovascular disease among both men and women.

Inequalities in mortality by social class measured at three stages of the lifecourse. Hart CL, Davey Smith G, Blane D. *Am J Public Health*. 1998;88:471–4.

Adverse socio-economic conditions in childhood and cause-specific adult mortality: prospective observational study. Davey Smith G, Hart CL, Blane D, Hole D. *Br Med J*. 1998;316:1631–5.

The Collaborative Study included indicators of participants' social position at different stages of life from childhood to middle-age. It was found that father's occupation, educational attainment, own first and most recent occupation, place of residence and known risk

behaviours in adulthood all made additive contributions to subsequent mortality. The risks of specific causes of death were variously influenced at different life stages. For example, people whose fathers had manual occupations were more likely to develop coronary heart disease, stroke or stomach cancer. On the other hand, higher mortality from lung cancer, other cancers and accidents and violence was associated with risk factors related to manual occupations in adulthood such as smoking, alcohol and hazards at work.

Effect of tobacco smoking on survival of men and women by social position: a 28 year cohort study. Gruer L, Hart CL, Gordon DS, Watt GCM. *BMJ*. 2009;338:b480.

The interactive effects of smoking, gender and social position on long-term survival were examined using the Renfrew and Paisley cohort. The cohort members were divided into 24 mutually exclusive groups according to their sex, social class and smoking status. Both male and female smokers in all social positions had poorer survival than never-smokers in even the lowest social positions. The differences in survival between smokers and never-smokers were much greater than those between smokers in different social positions or never smokers in different social positions. Smoking itself was thus a greater source of health inequality in this population than the sum total of other factors related to social position. Smoking also cancelled out women's otherwise large survival advantage over men. This suggests the scope for reducing health inequalities related to social position is probably limited, in this and similar populations, unless many smokers in lower social positions can be enabled to stop smoking.

Cause specific mortality, social position, and obesity among women who had never smoked: 28 year cohort study. Hart CL, Gruer L, Watt GCM. *BMJ*. 2011;342:d3785. doi: 10.1136/bmj.d3785.

Among women in the Renfrew and Paisley Study who had never smoked, lower occupational position was associated with higher mortality rates from cardiovascular disease but not from cancer. All-cause mortality rates were a third higher in manual occupational classes than in non-manual classes I & II, and this was mainly explained by obesity, systolic blood pressure and lung function. Mortality rates were highest in severely obese women in the lowest occupational classes. Non-obese women had the lowest mortality rates, with little difference between the highest and lowest occupational classes.

As summarised in previous sections, people living in areas exposed to higher levels of black smoke pollution experienced higher short- and long-term mortality rates. People with lower childhood IQ had higher mortality rates aged under 65 but not over 65. All-cause mortality increased among men drinking more than 21 units of alcohol per week; smoking and heavy drinking made additive contributions to all-cause mortality; and heavy drinking and obesity increased the risk of liver disease supra-additively. Overweight and obesity led to higher all-cause mortality rates.

These studies provide a uniquely multifaceted view of the many interrelated factors influencing health in the west and central belt of Scotland during the 20th century. Specific causal factors such as tobacco smoke, alcohol and air pollution have interacted with people's childhood circumstances, cognitive abilities, cultural values and residential and occupational environments to generate widely different health experiences. Although the Midspan cohorts have lived through a unique epoch, they offer pointers to ways of improving health and reducing health inequalities in Scotland and elsewhere.

